

REMARKS/ARGUMENTS

In the Office action dated October 7, 2004, the Examiner rejected claims 1-15, all of the claims in the Application, under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-15 of U. S. Patent No. 6,774,004 B1, to Hsu *et al.*, granted August 10, 2004, on an application filed March 17, 2003, in view of U. S. Patent No. 6,774,054 B1, to Zhang *et al.*, granted August 10, 2004, on an application filed August 13, 2003, and presumably claims 1-20 thereof, although the precise claims were not identified in the Office action.

In the Specification, no changes.

In the Claims, claim 1 is amended to incorporate the limitations of originally presented claims 6 and 7; claims 10 and 15 are amended to correct a typographical error; new claims 16-20 are presented for consideration. Claims 4, 6 and 7 are cancelled.

The Invention

PCMO metal oxide is very hard to etch by a dry etch process. PCMO etching has been reported to include use of chlorine and argon, however, the etch rate is too low for commercial applications, and the masks used in the processes are unstable, and do not remain intact. The method of the invention provides a method of dry etching a Pt/PCMO/Pt stack using a single hard mask to provide a clean sidewall and field.

A top electrode may be dry etched according to the method of the invention through use of a gas mixture of Ar, O₂, and Cl₂, wherein the Cl₂ gas may be replaced by BC_l, CCl₄, SiCl₄, or a combination thereof. Microwave power is between about 400 W to 1000 W, and the substrate RF bias power is between about 10 W to 1000 W. After the top electrode is

etched, the same process may be used to etch the PCMO layer using a two step, or a multiple step, etching process, which has been found to provide better results. In the first etching step, Ar and O₂ and a chlorine-containing gas, comprise the etching chemistry, which is used to remove most of the PCMO thin film. In the second etching step, Ar and O₂ comprise the etching chemistry, which is used to remove the rest of the PCMO thin film. These two steps may be alternately applied in repeated cycles provided that shorter etching times are used in each step. The Ar, Cl₂ and O₂ etching chemistry provides a higher etch rate than when using only Ar and O₂ only ambient, however, using only Ar and O₂ provides for a cleaner side wall and field than when all three gases are used in the etching chemistry, thus resulting in a device that has a better throughput rate, and exhibits more reliable performance characteristics than if only a single step etching process were used on the PCMO, as is done in the prior art. The dry etching method of the invention may be applied to Ir/PCMO/Ir, Ru/PCMO/Ru, IrO₂/PCMO/IrO₂, and RuO₂/PCMO/RuO₂ capacitors.

The Applied Art

U. S. Patent No. 6,774,004 B1, to Hsu *et al.*, granted August 10, 2004, describes use of a TiN hard mask during etching of a PCMO layer in a single etching step. There is no "PCMO stack" as that term is defined in the instant application, wherein a layer of PCMO is sandwiched between a metal or metal oxide top electrode and a similar bottom electrode.

U. S. Patent No. 6,774,054 B1, to Zhang *et al.*, granted August 10, 2004, describes a PCMO layer sandwiched between metal top and bottom electrode, however, there is no etching of the PCMO layer in this reference.

The Claims

Claim 1 now fully sets forth all of the details of the method of the invention with respect to the multi-step etching of a PCMO layer sandwiched between a top electrode and bottom electrode. The applied references do not render this method obvious under any provision of the United States Code, nor under any judicially created doctrine. Claim 1 is allowable over the applied art and does not constitute double patenting under any theory.

Claims 2 and 3 describe the very specific parameters used to dry etch the top electrode, and do so without damaging the PCMO layer. The claims are allowable over the applied art, as such parameters are neither taught nor suggested by either reference, nor by a combination of the two references. The reasons for using these specific parameters are set forth in the specification, pages 3-5.

Claim 5 requires that the first and second etching steps be alternately applied. This procedure is neither taught nor suggested by the applied references, either singularly or in combination, and the claim is allowable over the applied art.

Claims 8 and 9 describe the very specific parameters used to dry etch the bottom electrode, and do so without damaging the PCMO layer. The claims are allowable over the applied art, as such parameters are neither taught nor suggested by either reference, nor by a combination of the two references. The reasons for using these specific parameters are set forth in the specification, pages 3-5.

Claim 10 is allowable with its allowable parent claim.

Claim 11, as originally filed, requires a multi-step etching process be applied to the PCMO layer. This element is neither taught nor suggested by the applied references, either

separately or in combination, and the claim is allowable thereover.

Claims 12 and 13 describe the very specific parameters used to dry etch the top electrode, the PCMO layer and the bottom electrode, and do so without damaging the PCMO layer. The claims are allowable over the applied art, as such parameters are neither taught nor suggested by either reference, nor by a combination of the two references. The reasons for using these specific parameters are set forth in the specification, pages 3-5.

Claim 14 is allowable for the reasons set forth in connection with claim 5.

Claim 15 is allowable with its allowable parent claim.

Newly presented claim 16 and its dependent claims are modelled on claims 11-14.

Claim 16 is allowable for the reasons set forth in connection with claim 11.

Claims 17 and 18 are allowable for the reasons set forth in connection with claims 11, 12 and 13.

Claim 19 and 20 are allowable for the reasons set forth in connection with claims 13 and 14, respectively.

In light of the foregoing amendment and remarks, the Examiner is respectfully requested to reconsider the rejections and objections stated in the Office action, and pass the application to allowance. If the Examiner has any questions regarding the amendment or remarks, the Examiner is invited to contact the undersigned.

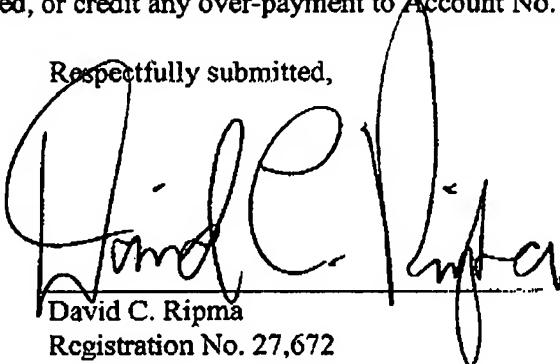
Provisional Request for Extension of time in Which to Respond

Should this response be deemed to be untimely, Applicants hereby request an extension of time under 37 C.F.R. § 1.136. The Commissioner is hereby authorized to charge

any additional fees which may be required, or credit any over-payment to Account No. 19-1457.

Date: 12/23/04

Respectfully submitted,



A handwritten signature in black ink, appearing to read "David C. Ripma".

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